



# **Analysis and Modeling of Southern California Deformation**

Jay Parker

with credit to (JPL):

Kenneth Hurst  
Andrea Donnellan  
David Jefferson  
Donald Argus  
Michael Heflin  
Gregory Lyzenga  
Frank Webb  
James Zumberge

and collaborators through  
SCIGN and GEM

## ANALYSIS AND MODELING OF SOUTHERN CALIFORNIA DEFORMATION

PARKER, J.W., JET PROPULSION LABORATORY, CALIFORNIA INSTITUTE OF TECHNOLOGY, PASADENA, CA 91109

The large and rich quantity of data now becoming available through the Southern California Integrated GPS Network (SCIGN) makes possible a wide variety of research involving analysis and modeling. The Hector Mine earthquake ( $M=7.1$ ) is the outstanding geophysical event so far registered by this network in its mature form, with 34 stations registering permanent deformation at the 95% confidence level. Inversion of this data for fault slip parameters was possible immediately after the event, and resulted in a pure GPS solution for the fault location, slip, and orientation, which have held up well under subsequent scrutiny. A new high-precision re-analysis of the SCIGN data has provided data sets for 71 stations with over one year's high-quality data. This data set has been subjected to principal components analysis, resulting in some marginal improvements in understanding at this preliminary stage. Finite element analysis in two and three dimensions is another important technique for explaining such network data, for example in comparing different hypothetical faulting structures and rheologies in the Los Angeles Basin. Automatic mesh generation based on geophysical fault and layering description is an important technology under development to assist the geophysical modeler.

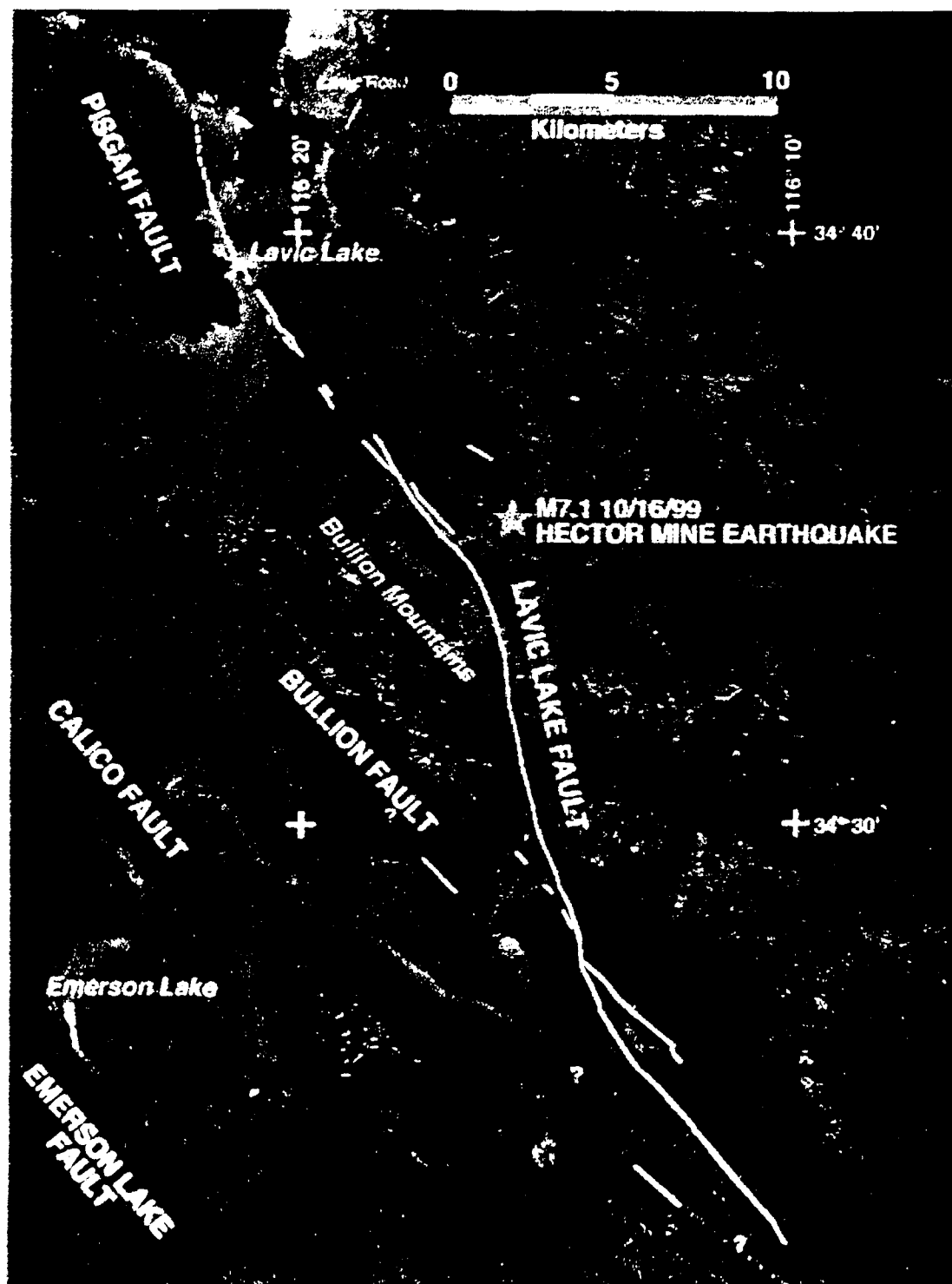


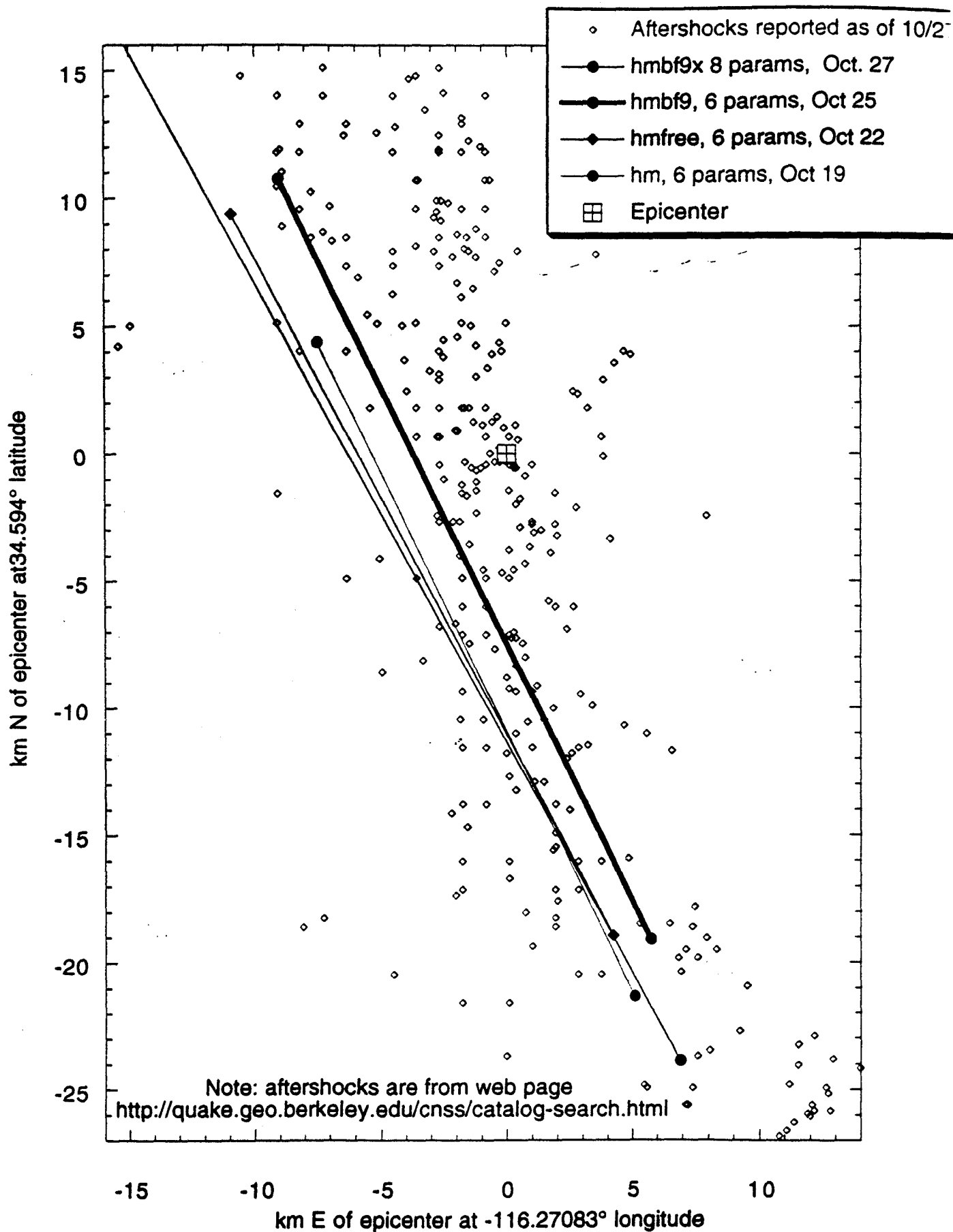
## Hector Mine EQ: pure GPS solution

- Initial solution for simple fault slip on web by EQ + 3 days ([milhouse.jpl.nasa.gov/hector](http://milhouse.jpl.nasa.gov/hector)).
  - Final solution posted EQ + 8 days, using 5day prior, 4day post-EQ delta.
  - Paper submitted to EOS within weeks of quake (now accepted GRL: Hurst et al.).
  - Total 47 stations, nearly all to west of quake, all > 35 km from event.
  - Free inversion by GeoFIT picked location, strike, and magnitude dead-on.
  - Model accepted as part of NOAA / NGS Horizontal Time Positioning Software.
- Next: automate it, make it a distributed component, expand modeling options (layered rheology, topography, multifault constraints)*



# Surface Rupture from the M7.1 Hector Mine Earthquake





# **JPL** *(preliminary)* Principal Components in SCIGN 2.0

- Ken Hurst, SGGS group have reprocessed SCIGN data from 1/1/98-4/1/00
- Regional ITRF97 and bias fixing reduce sigma from ~4 to ~1.3 mm in horizontal.
- Number of reporting stations nearing 250; 71 have high-quality data for > 1 year.
- 71 x 3 time series provides rich basis for **principal components analysis**.
- Missing data proved challenging: devised a mode-iterative approach to fill in
- Signal is, by far, constant velocity plus Hector snap (2 modes, 98.5% of variance)
- Other modes tend to tangle in similar-feature clusters.

*These clearly show:*

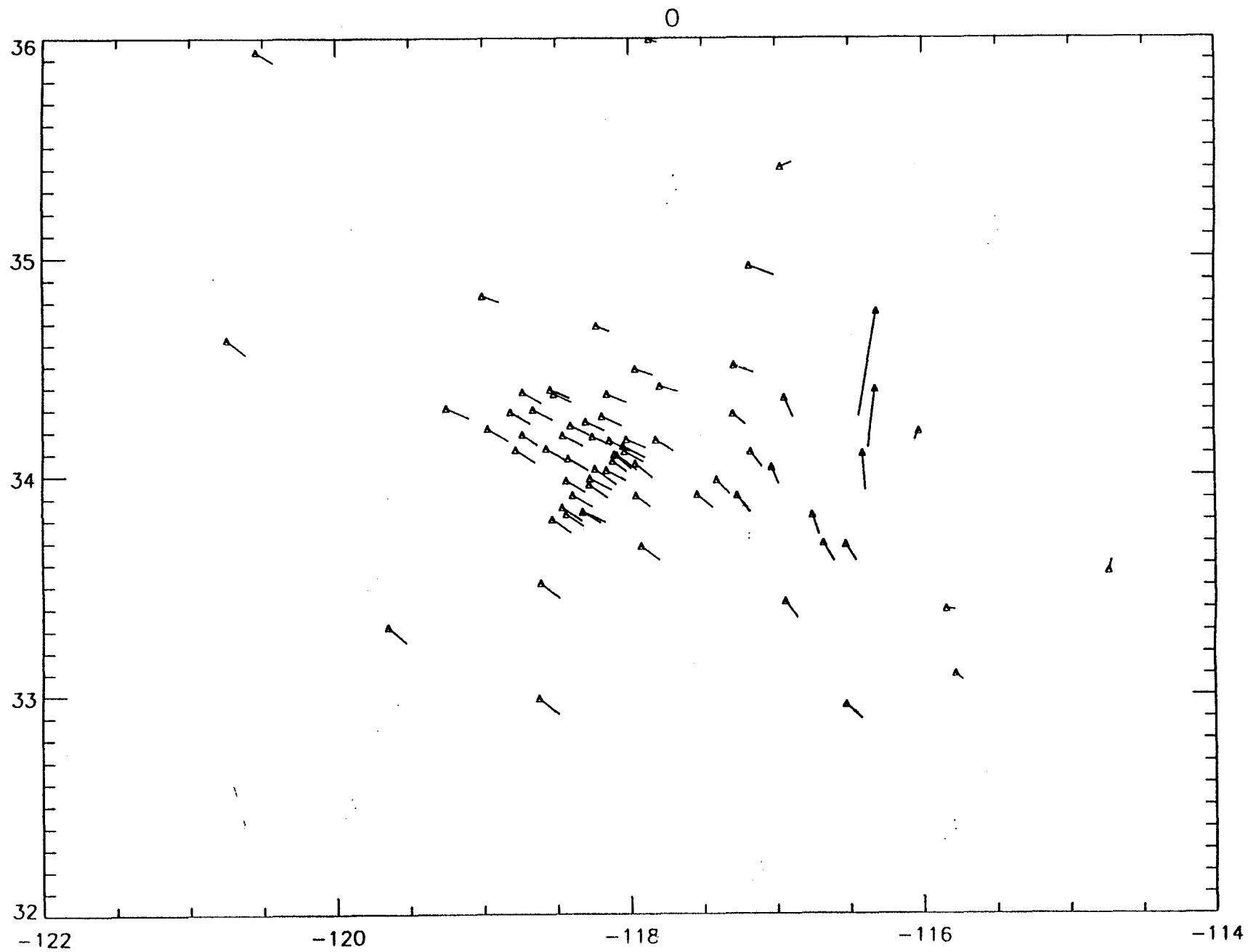
Annual and fortnightly components (thought due to poor ocean load model)

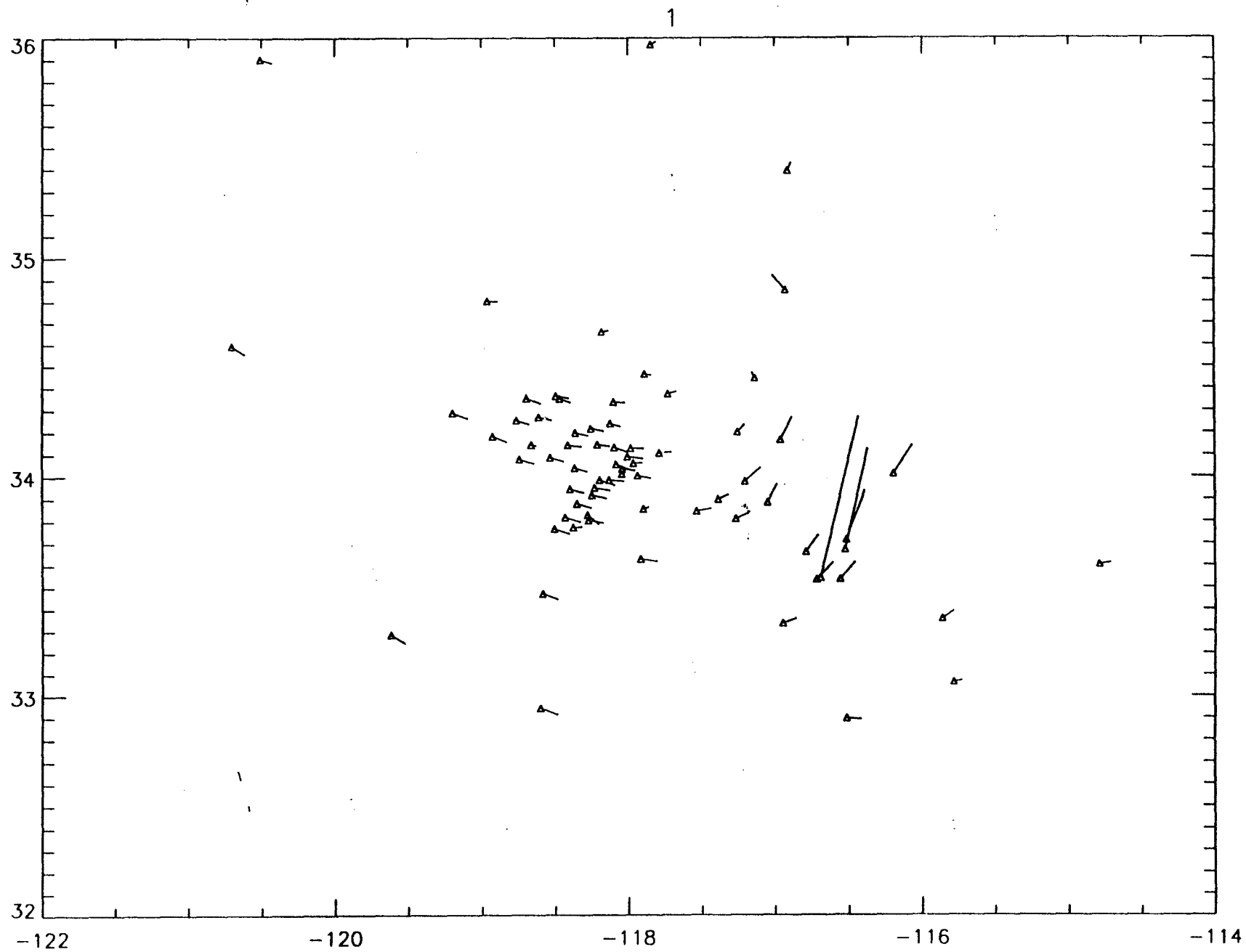
Other seasonal-to-annual scale components (hard to decipher so far)

*Possibly:* 3-8 day modes (Weather? Satellites?)

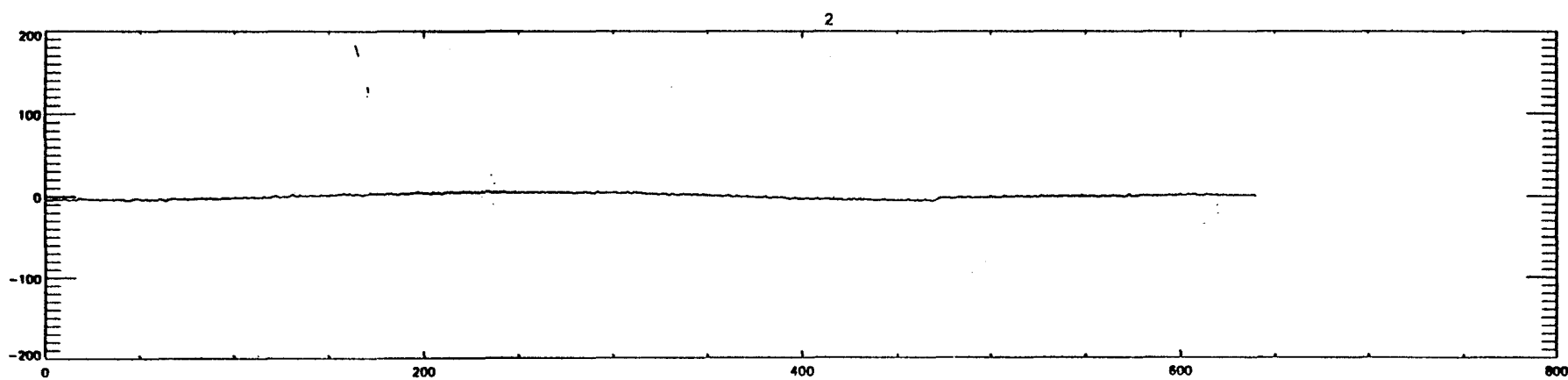
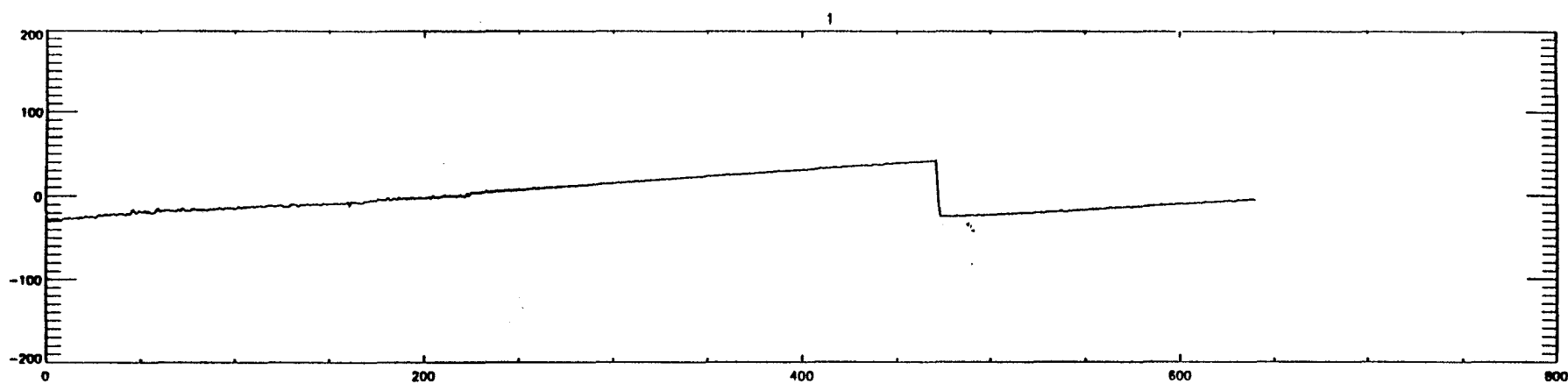
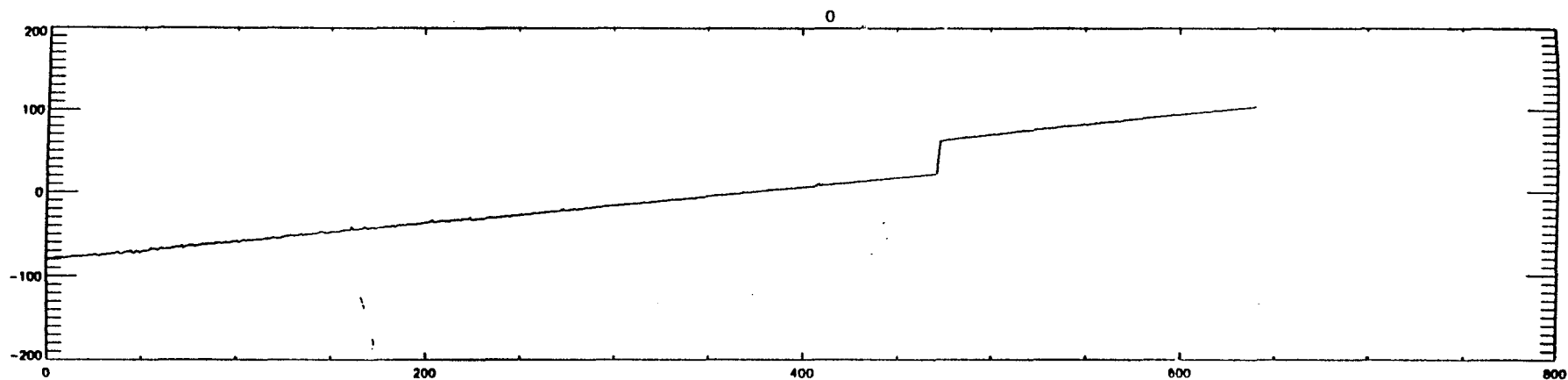
Hector relaxation (unclear best way to isolate from other effects)

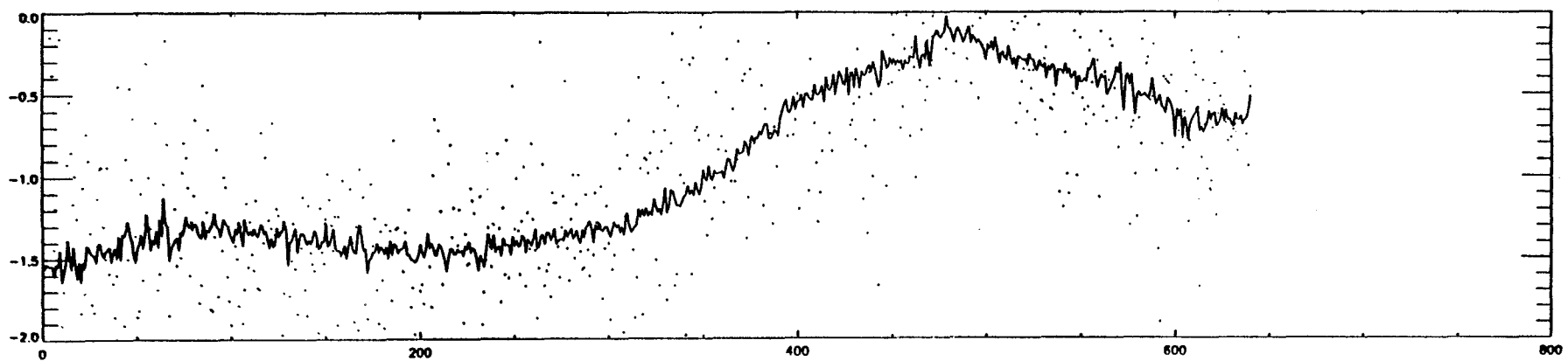
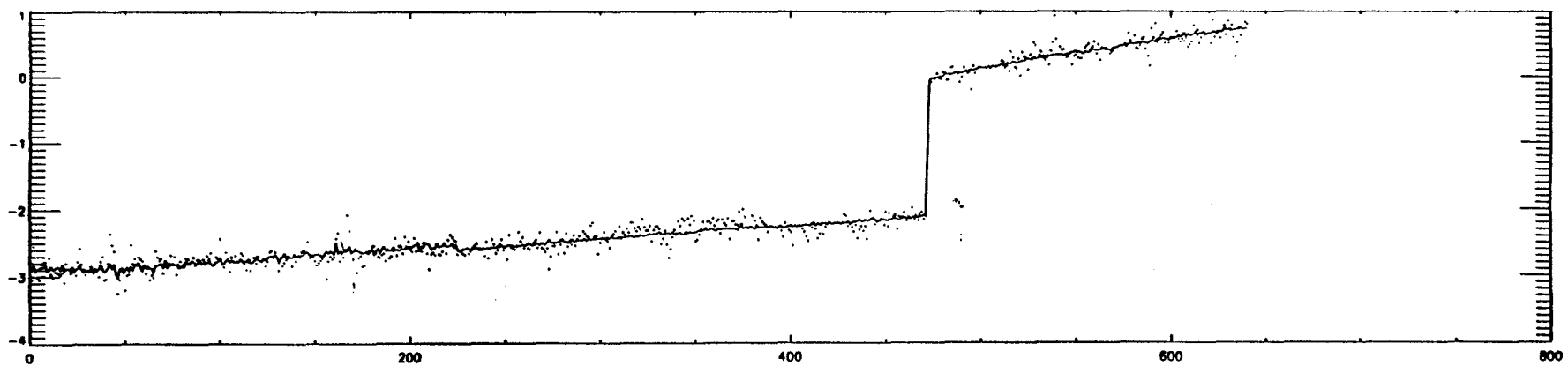
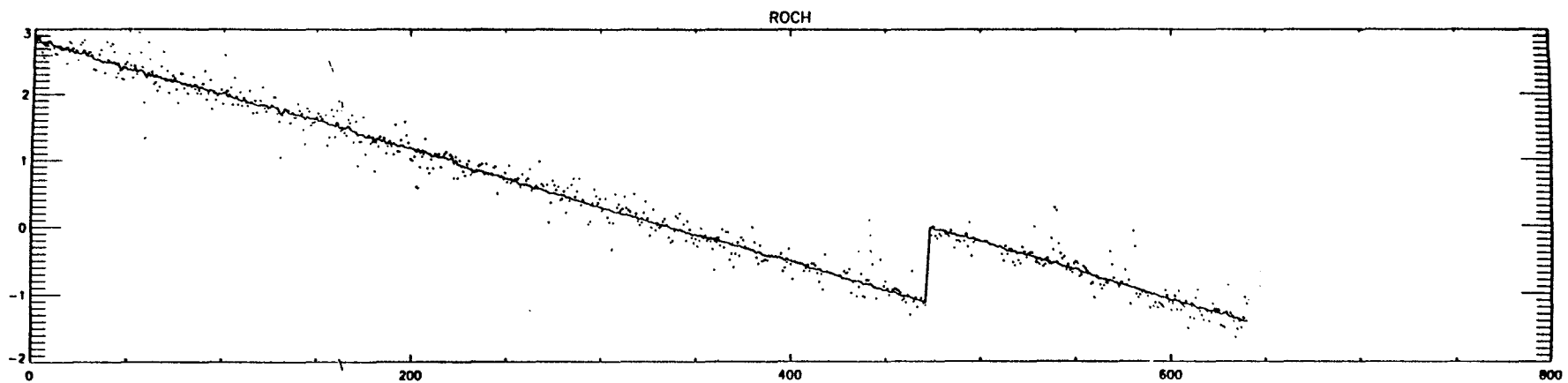
*Missing:* modes resembling reference frame noise (regional ITRF97 is superb)













## GeoGEN: mesh generation tools

- Fully 3D mesh tool for general faulting and rheology in progress (Jin-Fa Lee)
- Vertical cross-section tool supports GeoSIM LA Basin studies
  - Simple graphics/key entry interface
  - Communicates in geophysical terms
  - Allows user to specify conditions precisely (not just point-and-click)

